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Diseños experimentales de caso único y sus estadísticas

Single case experimental designs and their statistics

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Single case research provides a methodology for personalized healthcare or education in three forms: *observational*, e.g., measuring someone's pain and physical activity over 87 days (1); *quasi-experimental*, e.g., monitoring perceived relations between individuals before and after relations-focused training (2); and *experimental*, e.g., a *randomized starting point* of training across individuals in the previous example, or *randomized sequences* of treatment-control (3). In the latter example (3), patient Randy and his physician set up a two-week randomized placebo-controlled double-blind clinical trial on Randy, in which a pharmacist prepares fourteen identical capsules: seven with sleeping medication (E) and seven with placebo (C). The randomization occurs in seven blocks of two consecutive days. Randy rates his dizziness from 1 (*min*) to 7 (*max*) every morning and the results are as follows: 6(E)-5(C)-7(E)-4(C)-5(C)-6(E)-5(C)-7(E)-4(E)-5(C)-4(C)-6(E)-7(E)-6(C).

There are at least three ways to statistically test the treatment effect in this example, all in Open Source packages in *R* (4) and with documentation in Open Access literature. Firstly, Onghena (3) proposes a randomization test which for this example returns a different *p*-value depending on whether the design was a randomized block design (0.0781), a completely randomized design (0.0449) or an alternating treatments design (0.0463). For more details on these designs and other key aspects of single case experimental designs, Onghena (3) provides an excellent source. Secondly, one can build a regression model in *nlme* (6) in *R* (4) that accounts for the structure of the data (5); this example is presented in figure 1.

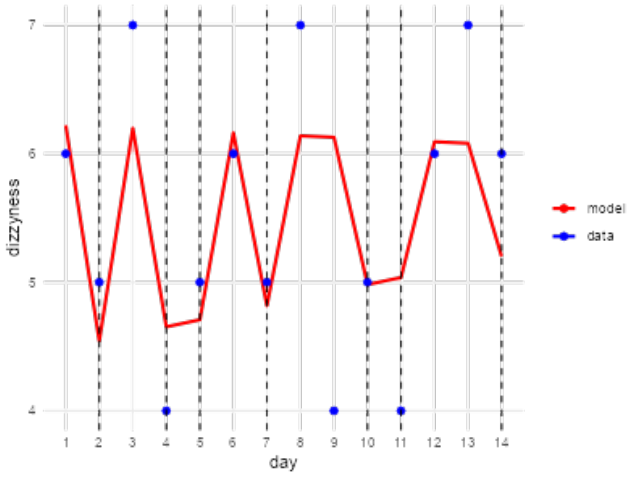

Figure 1. Randy's ratings of dizziness (blue), the best fitting model (red) and vertical dashed lines for placebo days.

For the treatment effect, this model returns a statistically non-significant outcome: B = 0.880, SE = 0.932, p = 0.367, 95% CI = [-1.196; 2.957]. Thirdly, the percentage of all non-overlapping data Bayes (PAND-B) (5) returns a 95% *credible interval* for the treatment

effect, in this example [0.595; 0.957]; this interval exceeds 0.5 and therefore indicates *more* dizziness in E.

Each way of analyzing the data has its pros and cons. The randomization test approach nicely accounts for the features of the design but returns only a *p*-value, which is a limitation recognized by Oghena (3) and many others for a long time (7). While the regression model can account for trends and provides a variety of statistics instead of just a *p*-value, it relies on somewhat restrictive assumptions including equal distance between measurements, at least interval (not ordinal or nominal) level of measurement and approximately bell-shaped residuals, assumptions which are not needed for the other two solutions. PAND-B provides a credible interval that can be updated if more data come in but cannot account for trends like the regression model does (5). Different solutions approach the same data under different assumptions to improve our understanding of a treatment effect on an individual (5, 8), and meta-analytic models can be used to combine individual findings into group-level findings (5, 9) when of interest.

Although this article builds on a borrowed example on dizziness (3), education-related examples are available as well (2, 5). Besides, dizziness has relevance for both healthcare and education, for our physical and mental wellbeing influence our ability to learn. However, the methodology and statistics part of curricula in medical and other health-related programs across the world remains focused on group-level research, and single case research is often barely mentioned or not even mentioned at all. Given its potential for healthcare and education, single case research should be part of any medical/health curriculum. Its results are easy to visualize and analyze, using freely available Open Source software, and consulting Open Access literature where several solutions are documented in detail. For researchers who are not familiar with programming in *R*, the randomization test approach is available via a graphical user interface (no programming needed) package in *R* commander (10), and PAND-B can be done among others via the Bayesian binomial tests modules in the freely available and Open Source button-and-click programs JASP (11) and *jamovi* (12). The latter is a package which has been recommended in this journal already for a while (13, 14) and comes with the additional advantage that it allows users to perform analyses without programming but to see the syntax (programming code) that would be needed to perform the same analyses in *R*.

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